On the Predictability of Tropical Cyclones through All-sky Infrared Satellite Radiance Assimilation

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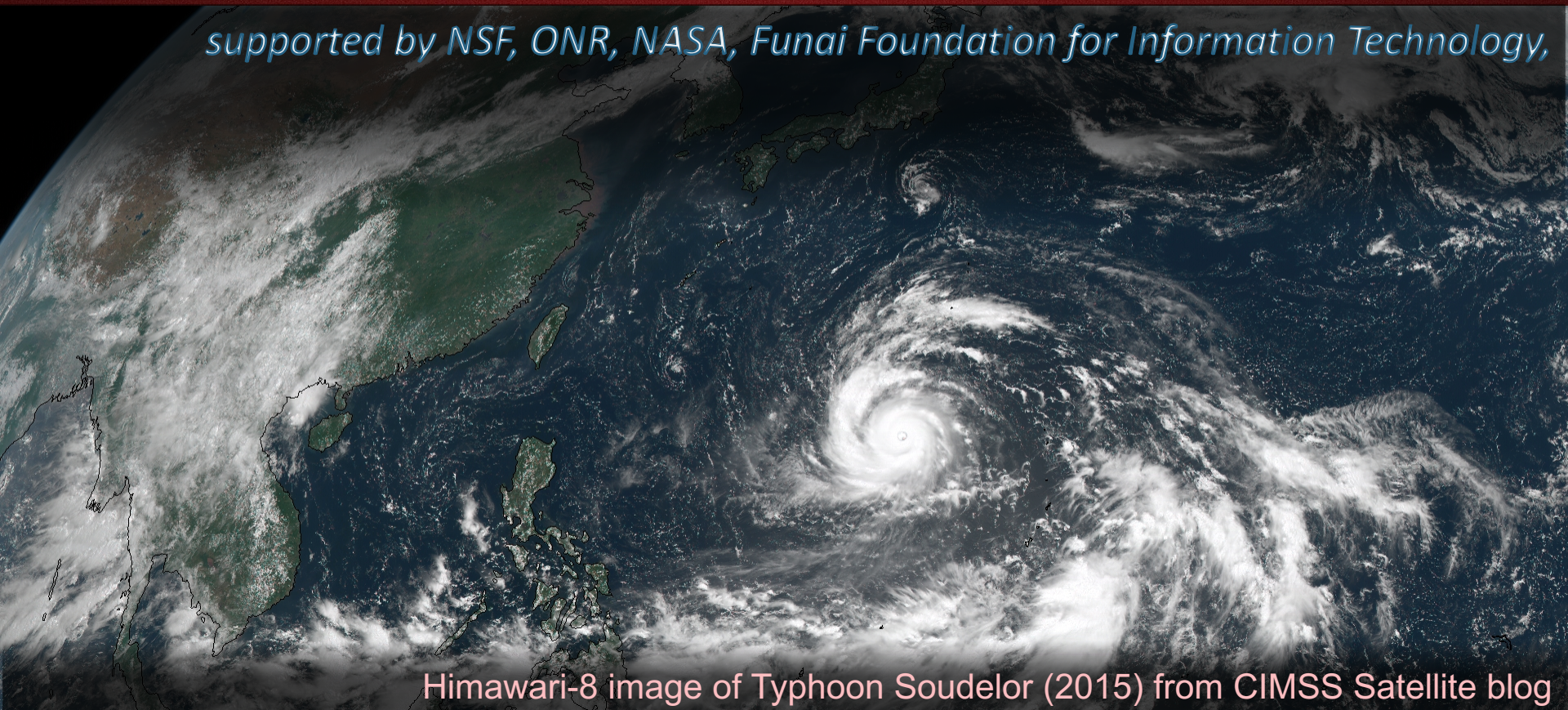


Himawari-8 image of Typhoon Soudelor (2015) from CIMSS Satellite blog

New Satellites! ~Himawari-8 & GOES-16~

Launch Dates:

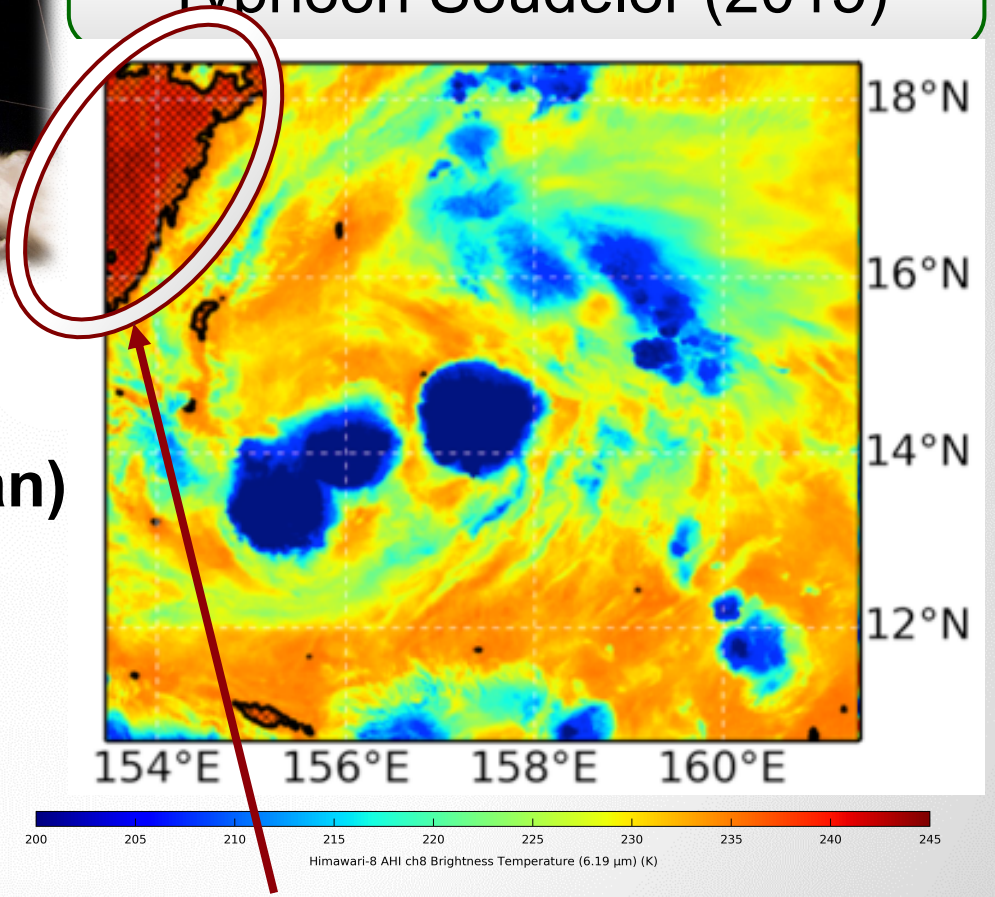
- **Oct 2014 (Himawari-8, Japan)**
- **Nov 2016 (GOES-16, USA)**

Coverage: **Hemispheric**

Frequency: **10-15 minutes**

Resolution: **2 km**

Himawari-8 observation of Typhoon Soudelor (2015)



Clear-sky seldom covers inner-core region

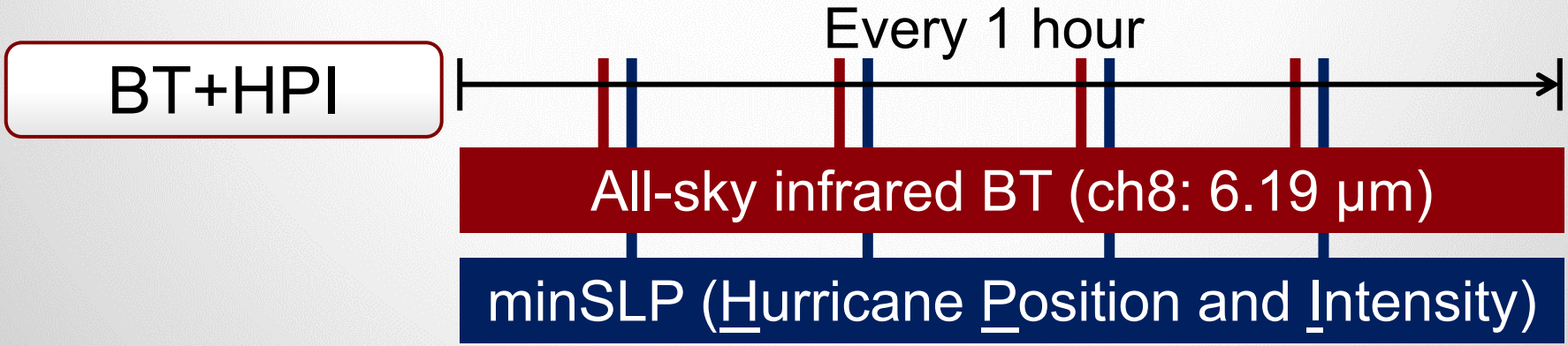
Experimental settings for tropical cyclones

DA cycle: **Genesis stage to predict RI**
Model: **WRF** ver.3.6.1(Skamarock 2008), **CRTM** (Han et al. 2006)
PSU WRF-EnKF-CRTM (Zhang, Minamide and Clothiaux, 2016)

Ensemble-based data assimilation system
- Ensemble size: 60

Regional convective-permitting model
- Resolution: 27, 9 & 3 km (D1-D3)

Observation error modeling
- Adaptive Observation Error Inflation (AOEI) — Minamide and Zhang, 2017, *MWR*
- Adaptive Background Error Inflation (ABEI) — Minamide and Zhang, in review for *QJRMS*

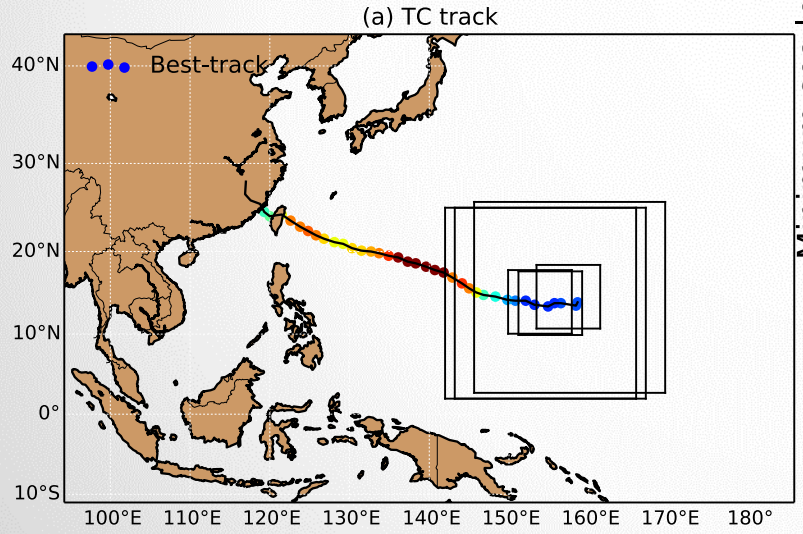


Second case: Super-Typhoon Soudelor (2015)

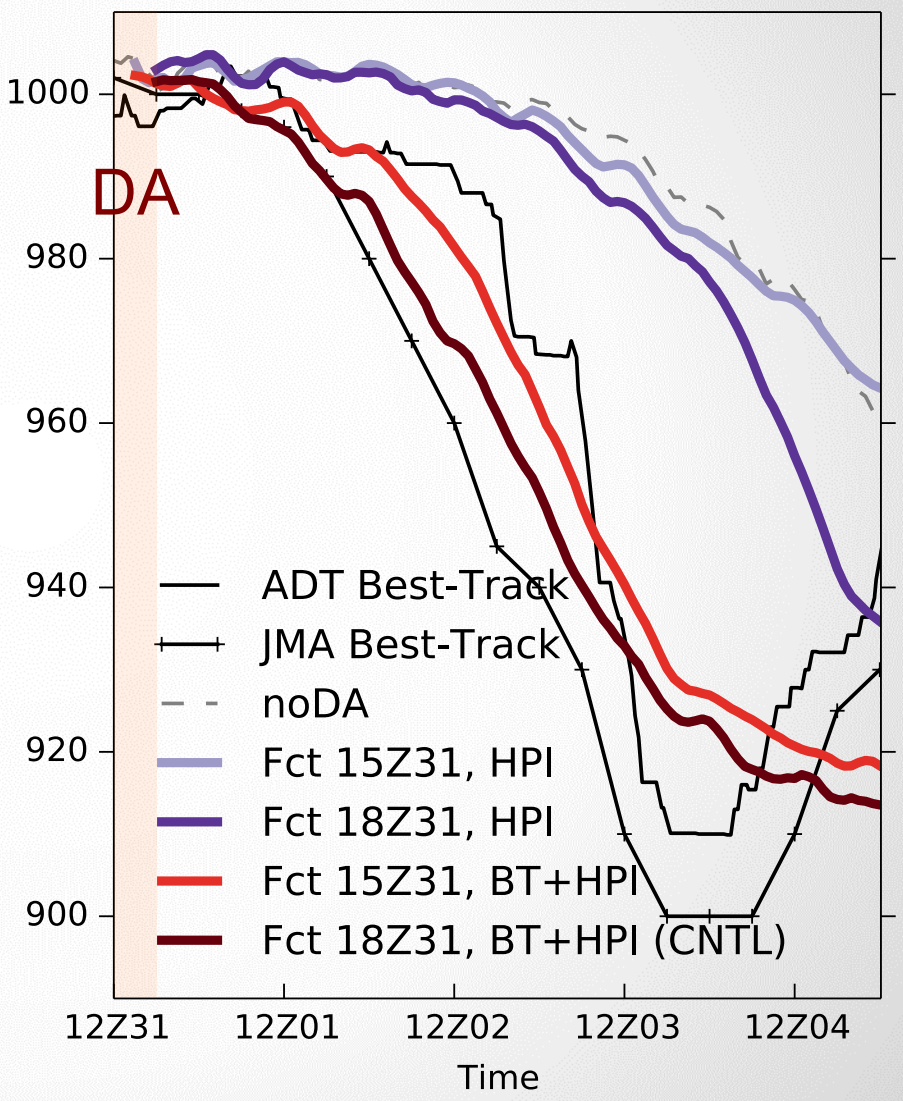
Super-Typhoon
Soudelor (2015)

- Observed by Himawari-8
- Strongest typhoon in 2015

DA cycle: **12Z to 18Z/31**
(Genesis stage to predict RI)

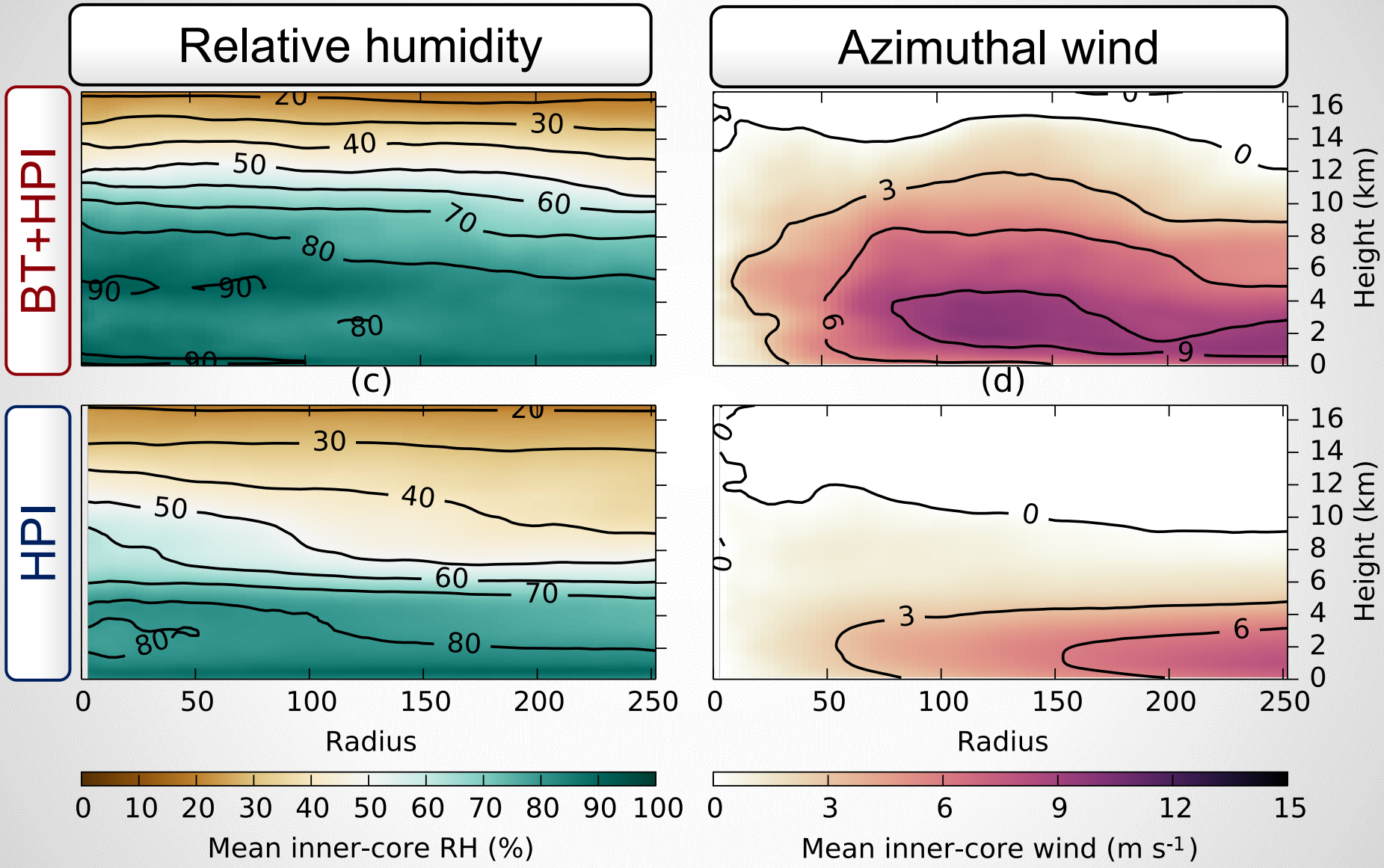


Minimum SLP forecast



Minamide and Zhang, 2018, *MWR*

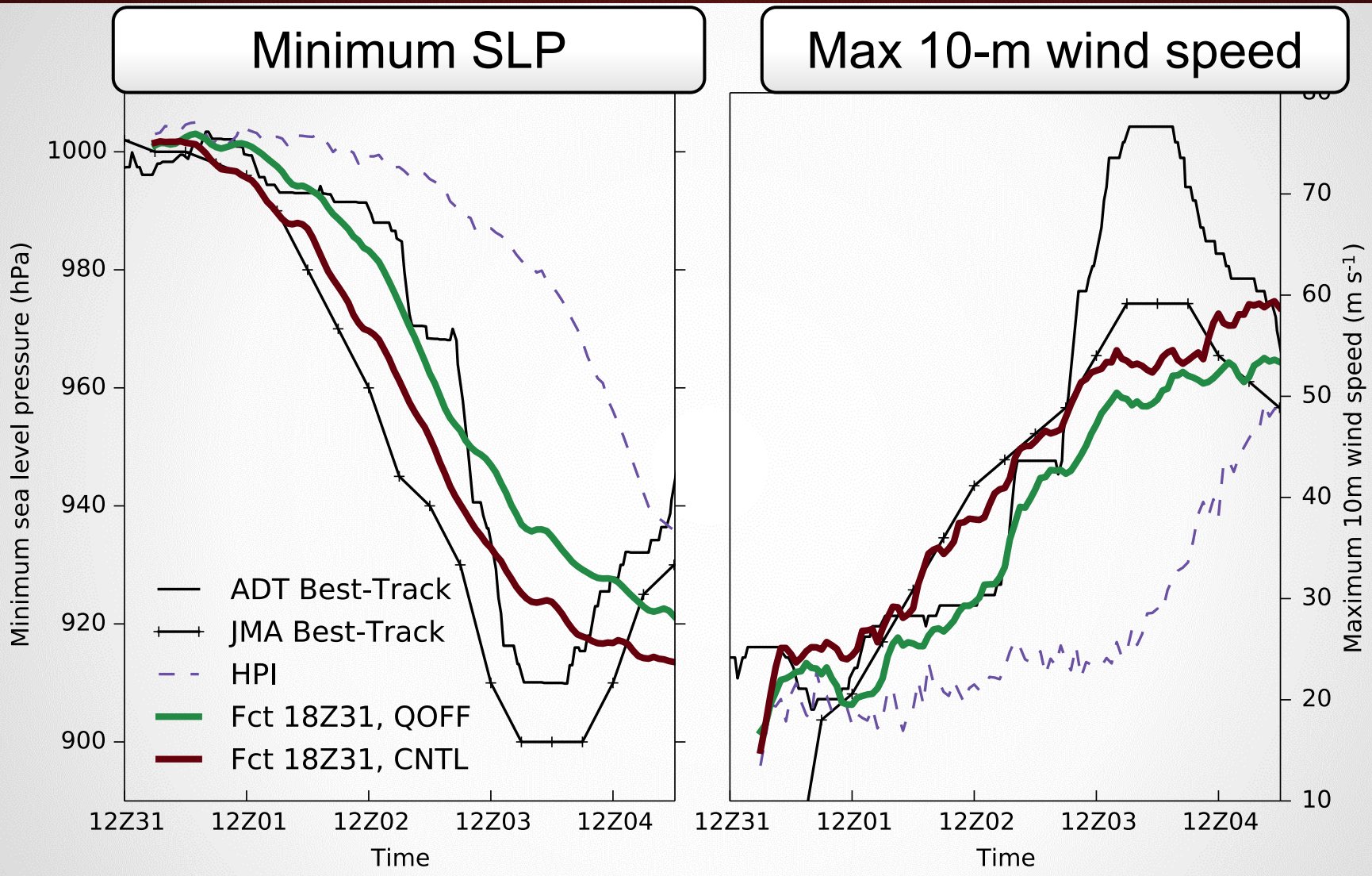
TC Inner-core structure comparison



- Stronger and moister inner-core vortex is obtained by all-sky DA.

Minamide and Zhang, 2018, *MWR*

Moisture initializations & TC intensity evolution



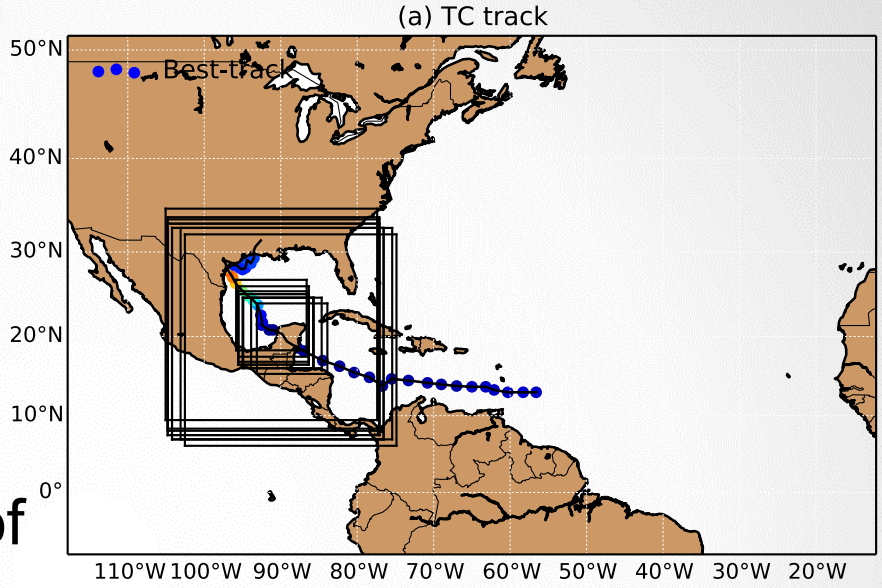
- Assimilation of BT significantly contributed both moisture & dynamical vortex initialization.

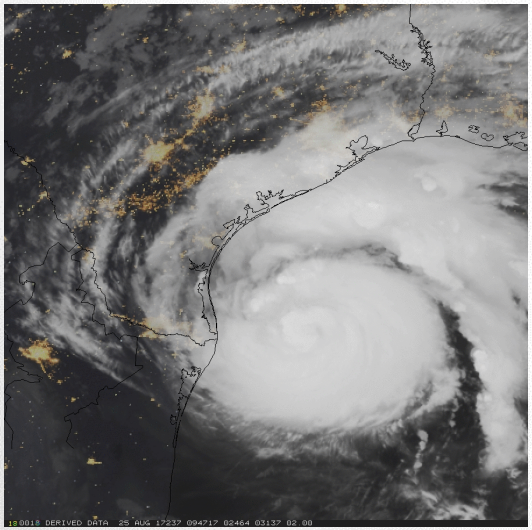
Minamide and Zhang, 2018, *MWR*

Second case: Hurricane Harvey (2017)

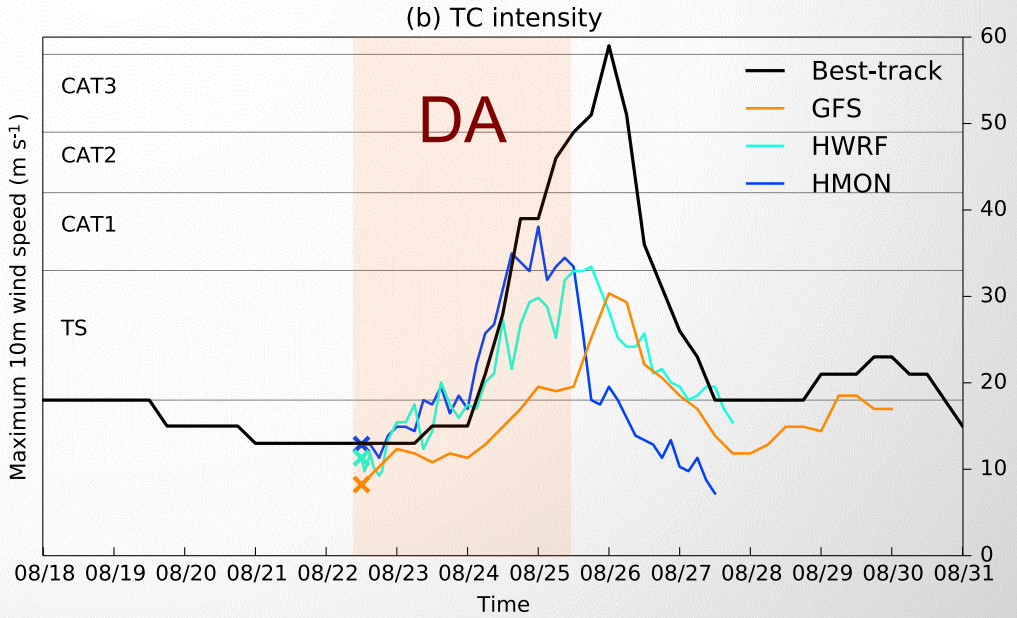
Hurricane Harvey (2017)

- First landfall major hurricane observed by GOES-16
- Re-intensified in the Gullf of Mexico



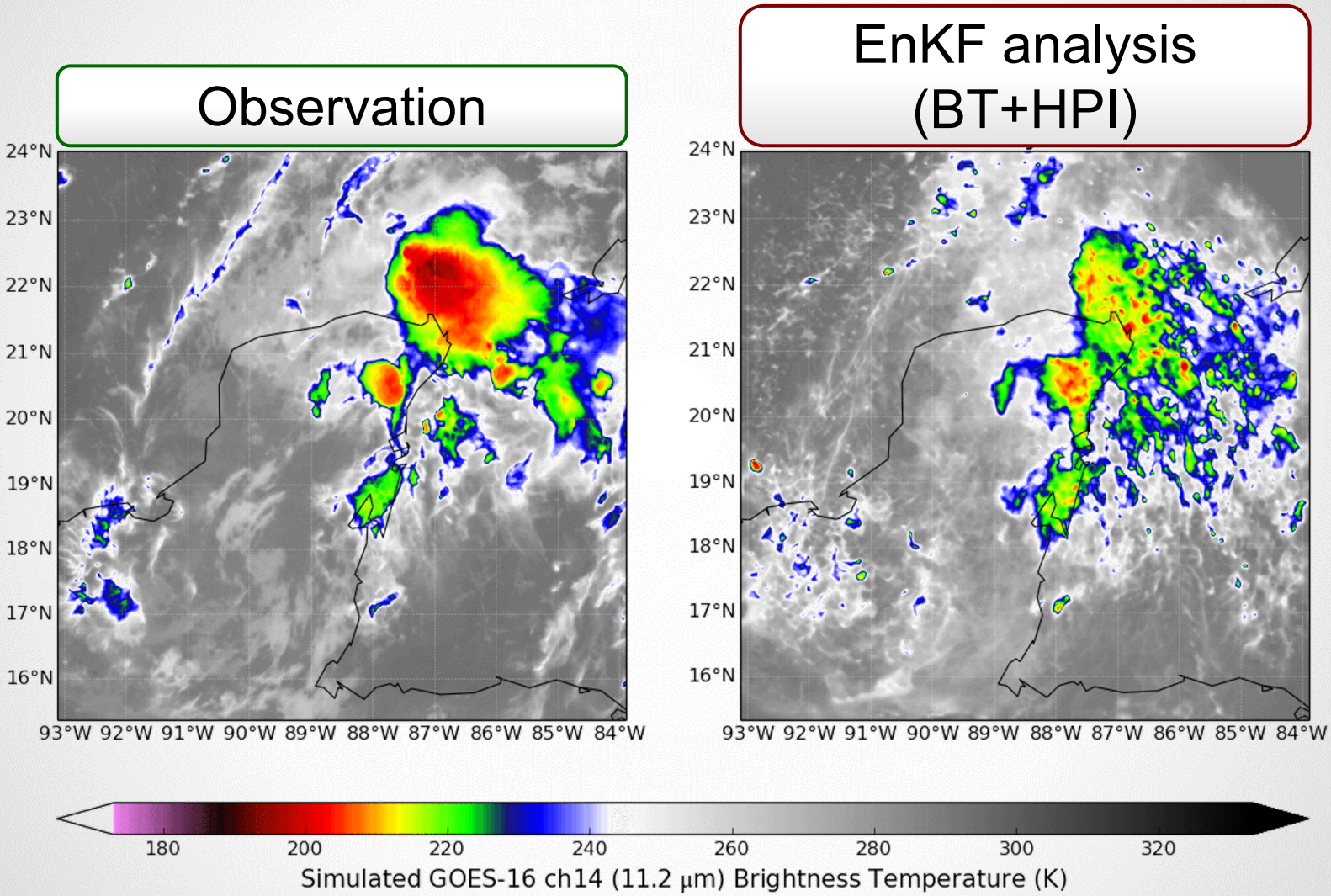


GOES-16 animation from http://tropic.ssec.wisc.edu/



EnKF Performance Assimilating Himawari-8 BT

GOES-16 **Window** Channel (ch14: 11.2 μm)



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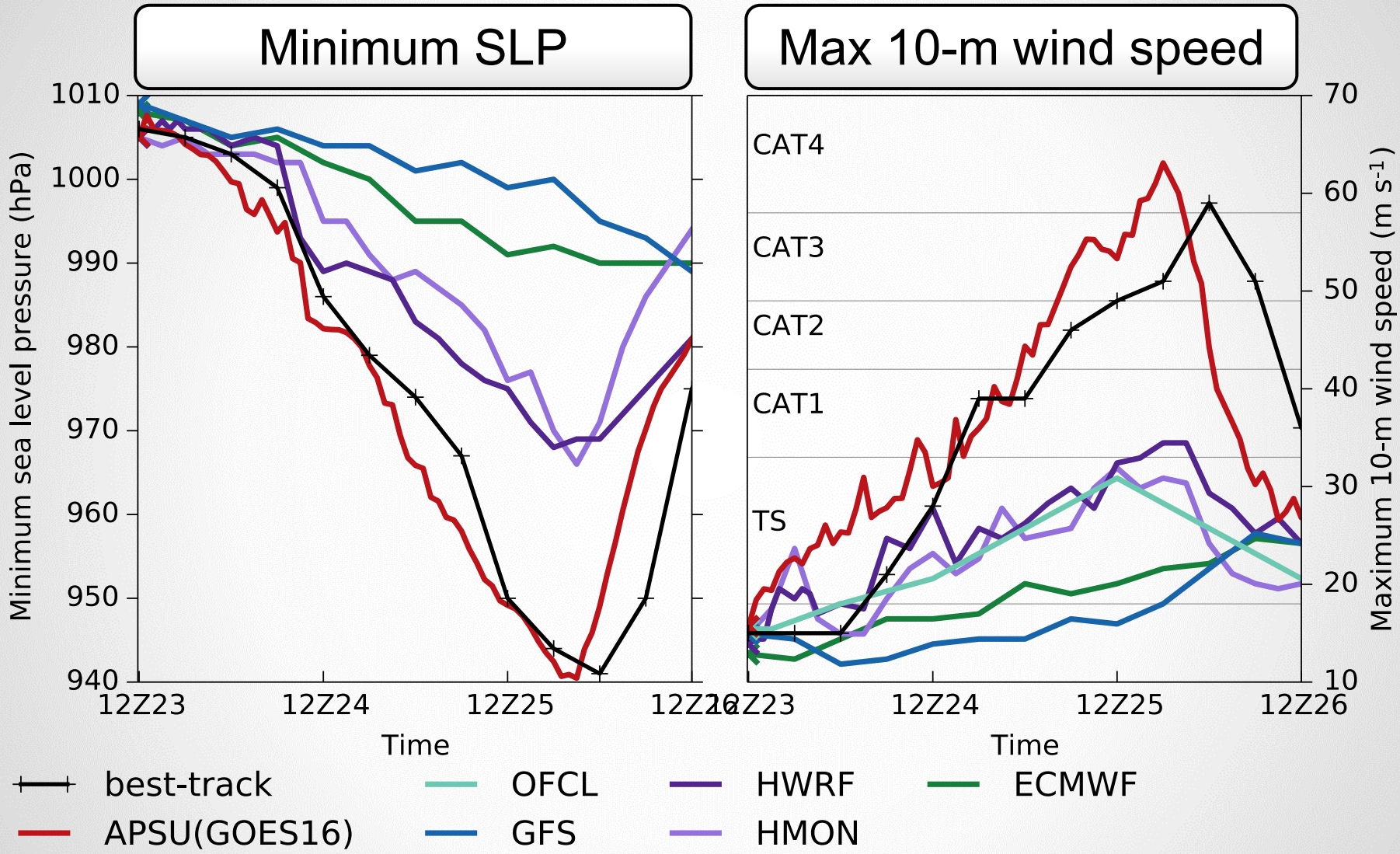
Minamide and Zhang, *in prep for submission*

EnKF Performance on TC intensity forecast



- Assimilation of GOES-16 helped to capture RI of Harvey.

Minamide and Zhang, *in prep for submission*

Summary

- Assimilation of brightness temperatures for tropical cyclones can contribute to developing strong vortex, as well as constraining observed moisture (and convection) distribution.
- Assimilation of all-sky brightness temperatures of water vapor channel from Himawari-8 and GOES-16 in the genesis stage greatly helped to capture the rapid intensification process of tropical cyclones with the deterministic forecasts from the EnKF analysis mean.

Thank you very much for your attention. (Masashi.Minamide@jpl.nasa.gov)